The Commonwealth of Massachusetts
Executive Office of Health and Human Services
Department of Public Health
Bureau of Environmental Health Assessment
250 Washington Street, Boston, MA 02108-4619

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January 16, 2001

Ann McCobb, Health Agent
Holliston Office of the Board of Health
Town Hall
Holliston, MA 01746

Dear Ms. McCobb:

As you know after consultation with your office and having received a complaint from a parent, the Bureau of Environmental Health Assessment (BEHA) conducted an evaluation of the indoor air quality at the Holliston High School. Michael Feeney, Chief of Emergency Response/Indoor Air Quality (ER/IAQ), BEHA, conducted this inspection on December 21, 2000 accompanied by Michael Cassidy, Chief of the Holliston Fire Department, and you. Mr. Feeney returned on December 22, 2000 with Mr. Cory Holmes of BEHA to conduct general air monitoring in occupied areas of the building. Reports of evacuation of the building because of elevated carbon monoxide levels as well as concerns about pollutants generated by renovation efforts and the potential impact on occupied classrooms prompted this request for an assessment. Preliminary information concerning renovations are the subject of this letter. General air monitoring results of testing conducted on December 22, 2000 will be subject of a separate report.

The school is currently under renovation while occupied by students, teachers and school staff. It was reported that the entire school is planned to be renovated. At the time of the inspection, a significant portion of the science wing, the auditorium, areas around the gymnasium and general classrooms along the two-story wing were all under renovation. Temporary walls were erected in several areas to separate construction zones from occupied areas. Spaces in the temporary walls (see Picture 1), rips in plastic containment (see Picture 2) and no containment around doors (see Picture 3) were observed throughout the building.

In order to assess whether containment measures were effective to prevent pollutant movement from construction areas into occupied areas of the high school, air monitoring for ultrafine particles were conducted on both days around each blocked door as well as within each construction site. Carbon monoxide air levels were also measured on December 22, 2000 since the building was evacuated because of vehicle exhaust penetrating into occupied space (HHS, 2000). Construction activities (e.g. grinding, cutting, demolition) as well as the combustion of fossil fuels can produce particulate matter that is of a small diameter [10 microns (μ)] that can penetrate into the lungs and cause irritation. For this reason a device that can measure 10 μ or less particles was also used to identify pollutant pathways from construct sites into the occupied areas. Air tests for carbon monoxide were taken with the TSI, Q-Trak ™, IAQ Monitor Model 8551. Air tests for ultrafine particulates were taken with the TSI, P-Trak ™ Ultrafine Particle Counter Model 8525. The tests were taken under normal operating conditions. Test results appear in Tables 1-6.

During these assessments detectable levels [1 to 6 parts per million (ppm)] of carbon monoxide were detected in the science wing (see Tables). A carbon monoxide detector (TSI, Q-Trak ™) placed in Room 169 by consultants hired by Peabody Construction displayed a carbon monoxide reading of 4 ppm.

Increased levels of ultrafine particles over background levels taken in the interior of the school were noted throughout the building, with the highest concentrations noted around the gymnasium as well as door seams (see Picture 4), spaces around duct/wall junctions (see Picture 5), and a wire conduit (see Picture 6). These levels of both carbon monoxide and ultrafine particles indicate that particulate from construction activities are penetrating into occupied space.

There exist a number of conditions that influence the movement of air from renovation areas into occupied areas.

1. *Temperature Differentiation between Renovation and Occupied Spaces*-The renovation areas are open to the outdoors. Temperature in the renovation areas are expected to have a lower temperature than occupied areas. This temperature differentiation can result in movement of cold air to hot air, creating drafts that can penetrate through cracks, crevices, holes and seams in interior and containment walls, resulting in the introduction of vehicle exhaust and particulates into classrooms.

2. *Occupied Areas Are under Negative Pressure*-The operation of classroom exhaust vents combined with deactivated or poorly operating unit ventilators creates negative pressure. If classrooms are under negative pressure (similar to a vacuum effect), air

3. and pollutants from the renovation areas can be drawn into classrooms through cracks, crevices, holes and seams in interior and containment walls.

4. *The Renovation Areas Are under Positive Pressure*-The renovation areas can become positively pressurized during southwest winds. The south side of the building has tarps with holes over an opening in the exterior wall (see Picture 7). A steady southwest wind can force air into the renovation area, which creates positive air pressure. If the renovations are positively pressurized, air and pollutants from the renovation areas can be forced into classrooms through cracks, crevices, holes and seams in interior and containment walls.

The carbon monoxide and ultrafine particulate air testing indicated that seams and spaces in temporary containment walls and seams sealed with duct tape are not sufficient to prevent pollutant migration into occupied areas. Measures should be taken to reverse the air pressure relationship between the renovation areas and occupied spaces. Univents in all occupied classrooms should be operating to create positive pressure in classrooms. Once all univents are operating, general exhaust ventilation in classrooms should be reduced to maintain a slightly positive air pressure in classrooms.

Despite measures taken to limit pollutant migration into occupied areas, numerous pathways exist for pollutants to move from areas under renovation into occupied spaces. These pathways, coupled with air monitoring of carbon monoxide and ultrafine particles indicate that the temporary walls are not sufficient to contain pollutants related to renovation work. In addition to changing the pressure relationships of the occupied space to the areas under renovation, the following recommendations should be implemented as soon as possible in order to reduce the migration of renovation generated pollutants into occupied areas and to better address indoor air quality concerns:

1. Establish communications between all parties involved with building renovations to prevent potential IAQ problems. Develop a forum for occupants to express concerns about renovations as well as a program to resolve IAQ issues.

2. Develop a notification system for building occupants immediately adjacent to construction activities to report construction/renovation related odors and/or dusts problems to the building administrator. Have these concerns relayed to the contractor in a manner to allow for a timely remediation of the problem.

3. When possible, schedule projects which produce large amounts of dusts, odors and emissions during unoccupied periods or periods of low occupancy.

4. Disseminate scheduling itinerary to all affected parties, this can be done in the form of meetings, newsletters or weekly bulletins.

5. Obtain Material Safety Data Sheets (MSDS) for all construction materials used during renovations and keep them in an area that is accessible to all individuals during periods of building operations as required by the Massachusetts Right-To-Know Act (MGL, 1983).

6. Consult MSDS' for any material applied to the affected area during renovation(s) including any sealant, carpet adhesive, tile mastic, flooring and/or roofing materials. Provide proper ventilation and allow sufficient curing time as per the manufacturer's instructions concerning these materials.

7. Use local exhaust ventilation and isolation techniques to control for renovation pollutants. Precautions should be taken to avoid the re-entrainment of these materials into the building's HVAC system. The design of each system must be assessed to determine how it may be impacted by renovation activities. Specific HVAC protection requirements pertain to the return, central filtration and supply components of the ventilation system. This may entail shutting down systems (when possible) during periods of heavy construction and demolition, ensuring systems are isolated from contaminated environments, sealing ventilation openings with plastic and utilizing filters with a higher dust spot efficiency where needed (SMACNA, 1995).

8. Seal utility holes, spaces in and around temporary walls and holes created by missing ceiling tiles to eliminate pollutant paths of migration.

9. Seal all doors that access renovations with polyethylene plastic and duct tape. Consider creating an air lock of a second door inside the renovation space to reduce migration.

10. If possible, relocate susceptible persons and those with pre-existing medical conditions (e.g. hypersensitivity, asthma) away from areas of renovations.

11. Implement prudent housekeeping and work site practices to minimize exposure to renovation pollutants. This may include constructing barriers, sealing off areas, and temporarily relocating furniture and supplies. To control for dusts, a high efficiency particulate arrestance filter (HEPA) equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended.

We suggest that these steps be taken on any renovation project within a public building.

Please feel free to contact us at (617) 624-5757 if you are in need of further information or technical assistance.

Respectfully,

Suzanne K. Condon, Assistant Commissioner
Bureau of Environmental Health Assessment

cc/ Mike Feeney, Chief, Emergency Response/Indoor Air Quality, BEHA
Nancy Young, Superintendent, Holliston School Department
Michael Cassidy, Chief, Holliston Fire Department
Keith Gerritt, Principal, Holliston Middle School
Robert Labrecque, Senior Project Manager, Gilbane Construction
Senator David P. Magnani
Representative Barbara Gardner

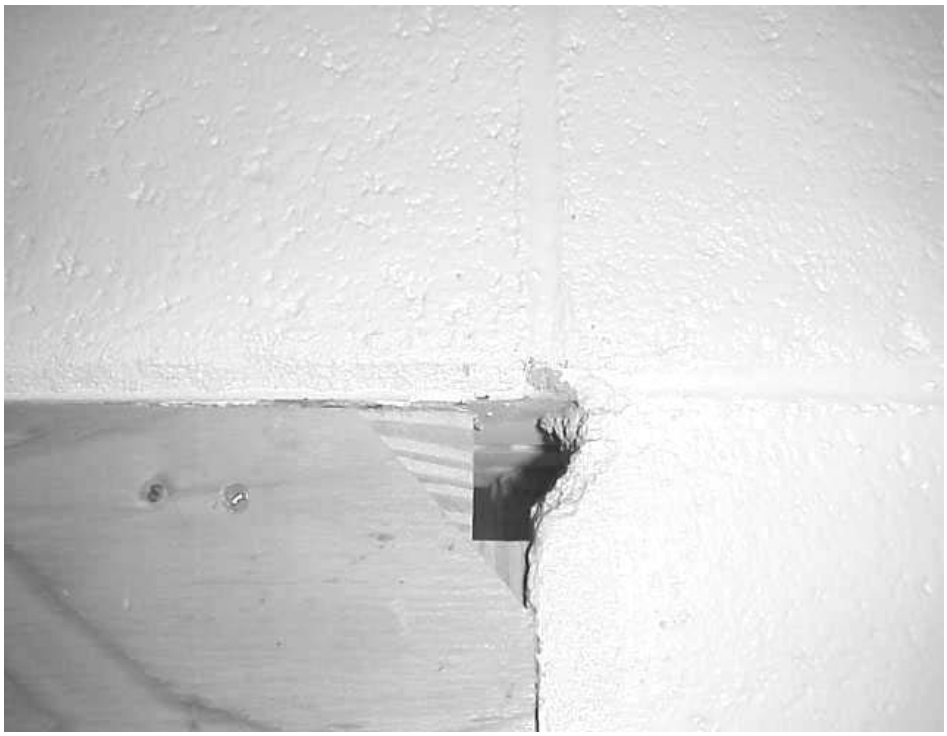
References

HHS. 2000. Principal's Newsletter. Holliston High School, Holliston, MA. November 2000.

MGL. 1983. Hazardous Substances Disclosure by Employers. Massachusetts General Laws. M.G.L. c. 111F.

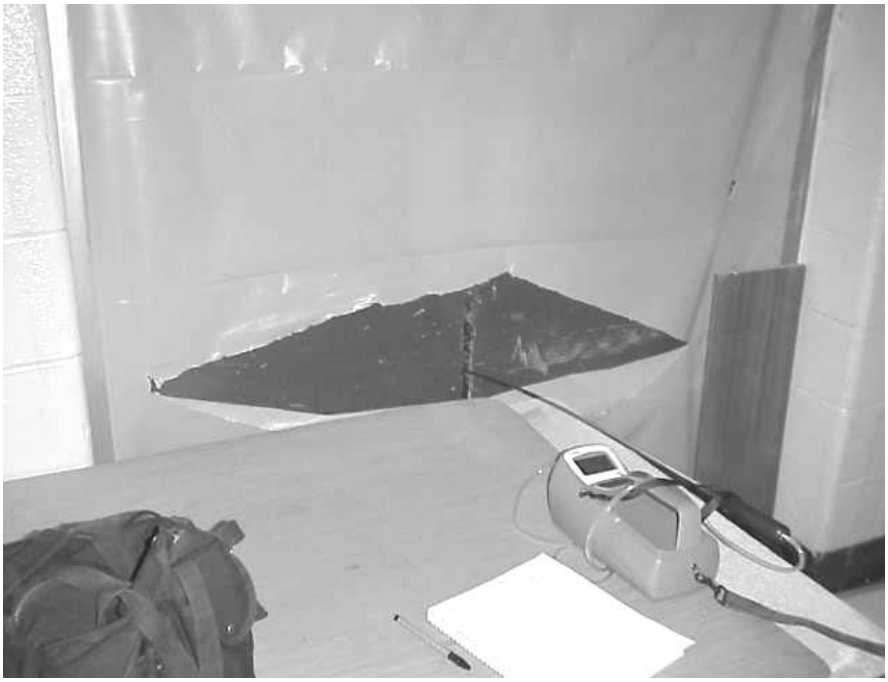
SMACNA. 1995. IAQ Guidelines for Occupied Buildings Under Construction. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

Picture 1



Space In Temporary Wall

Picture 2



Rip In Containment Plastic

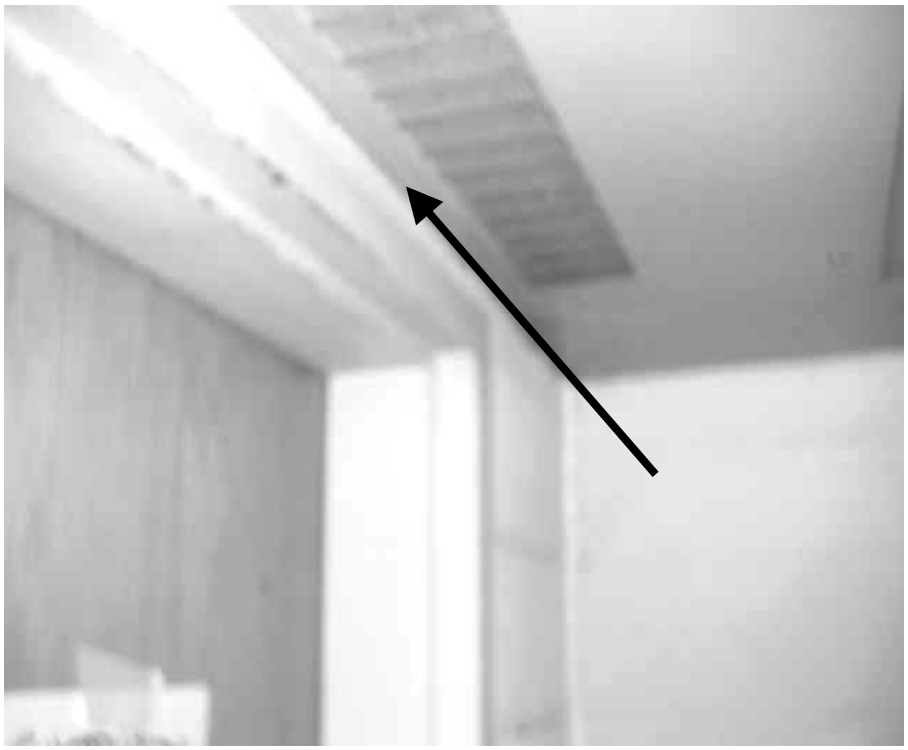
Picture 3

No Plastic Containment

Picture 4

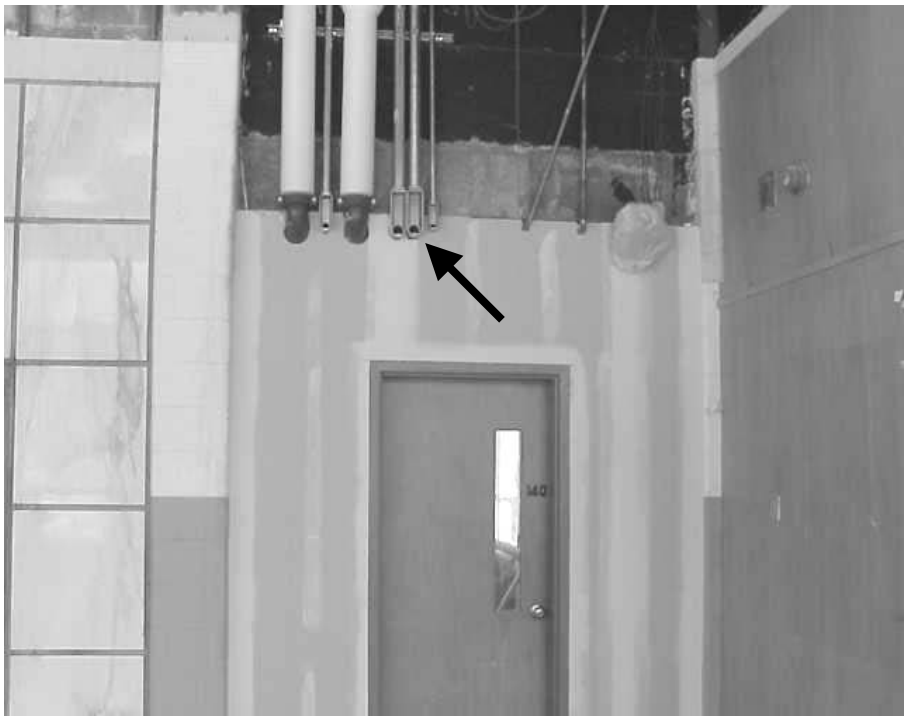
Unsealed Door Which Had Highest Ultrafine Particulate Measurements

Picture 5



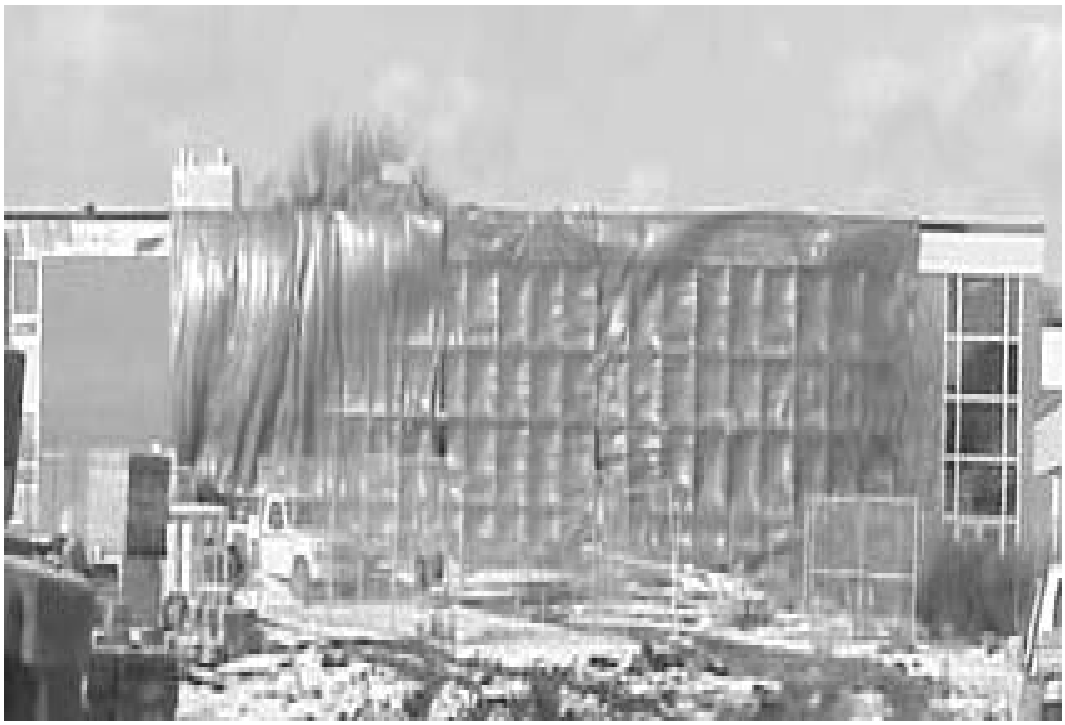
Wall/Univent Duct Seam

Picture 6



Pipe Conduit Serve as Pathway for Ultrafine Particles from Boiler Room

Picture 7



Exterior Containment for Renovated Wing

TABLE 1

Particulate Testing

Location: Holliston High School, Holliston, MA **Date: December 21, 2000**

Area	Location In Area	Number of Ultrafine Particulates Particles per cc of air (in thousands)[a]	Comments
Outdoors (background level)	On southwest corner of property	17	Upwind from school
Main hallway	Near auditorium at newly installed electrical conduit pipe over doorway	76	
Main hallway	Near auditorium 5 feet away from newly installed electrical conduit pipe over doorway	27	
Main hallway	Near cafeteria entrance	100	
Main hallway	Near gymnasium	78	
Main hallway	Near boiler room	171	
Main hallway	At door seam in renovations	398	
Boiler room	Center of room	60	
Boiler room	At parking lot entrance	32	
Boiler room	At electrical panel of newly installed electrical conduit pipe	49	
Booster storage	At door	220	

[a] Device measures total airborne particulates of a diameter 0.02-1 micrometers

TABLE 2

Particulate Testing

Location: Holliston High School, Holliston, MA **Date: December 21, 2000**

Area	Location In Area	Number of Ultrafine Particulates Particles per cc of air (in thousands)[a]	Comments
Main Hallway	At gymnasium wing temporary partition	266	
Main Hallway	Hole in containment at gymnasium wing temporary partition	233	
Cafeteria	East side	165	
Art Room	Center of room	102	
Kiln room	At doorway	46	Kiln in operation
Room 167	By AHU	53	
Room 167	At door of back wall	50	
Room 167	Center of room	42	
Room 167	At chemical hood	33	
Room 169	By AHU	41	
Room 169	Door seam of door adjacent to construction	60	
Room 169	AHU fresh air diffuser	48	

[a] Device measures total airborne particulates of a diameter 0.02-1 micrometers

TABLE 3

Particulate Testing

Location: Holliston High School, Holliston, MA **Date: December 21, 2000**

Area	Location In Area	Number of Ultrafine Particulates Particles per cc of air (in thousands)[a]	Comments
Room 169	Electrical outlet in wall shared with construction	38	
Room 169	At univent duct/wall seam	65	
Room 169	In below floor duct chase way	57	
Science wing hallway	Smoke door on exterior side of entrance door to science wing hallway	8.2	
Science wing hallway	Smoke door on interior side of entrance door to science wing hallway	19	
Science wing hallway	Hallway door near room 157	25	
Science wing hallway	At doorway of room 169	40	
Science wing hallway	At end of science wing hallway near room 169	57	
Cafeteria	At second unblocked exterior door next to plywood door plug	64	
100 corridor at high school wing	At new construction side of former hallway exterior door	30.3	
100 corridor at high school wing	At seam in plywood door plug	73.5	Unloading of truck on construction side
100 corridor at high school wing	At table ~20 feet from plywood door plug	6.7	

[a] Device measures total airborne particulates of a diameter 0.02-1 micrometers

TABLE 4

Particulate Testing

Location: Holliston High School, Holliston, MA **Date: December 21, 2000**

Area	Location In Area	Number of Ultrafine Particulates Particles per cc of air (in thousands)[a]	Comments
200 corridor at high school wing	At new construction side of former hallway exterior door	43	
200 corridor at high school wing	At seam in plywood door plug	10	
200 corridor at high school wing	At table ~20 feet from plywood door plug	9.4	

[a] Device measures total airborne particulates of a diameter 0.02-1 micrometers

TABLE 5

Carbon Monoxide and Particulate Testing

Holliston High School, Holliston, MA – December 22, 2000

Area	Location in Area	Number of Ultrafine Particulates Particles per cc of air (in thousands)[a]	Carbon Monoxide *ppm
Outside (Background)	Upwind on football field near clubhouse Front of building	12.2 22l	0
Chemical Storeroom	Center of room		3
157	Center of room	26	0
169 (Lab)	Center of room Univent duct/wall seam Door jam seam adjacent to rennovation	171 83 82r	5 6
167	Univent duct/wall seam	70	5
Science Prep Room	Hole in ceiling Second hole in ceiling tile east side of room Center of room	122 106 61	5
159	Door jam seam adjacent to rennovation Center door seam Center of room	77 91 52	5
153	Ceiling plenum Center of room	46 22	2
151	Univent duct/wall seam	15	0
Gym Hallway near 119	Center of hall	345	0
Room next to 119	Under door	383	0

* ppm = parts per million

[a] Device measures total airborne particulates of a diameter 0.02-1 micrometers

TABLE 6

Carbon Monoxide and Particulate Testing

Holliston High School, Holliston, MA – December 22, 2000

Area	Location in Area	Number of Ultrafine Particulates Particles per cc of air (in thousands)[a]	Carbon Monoxide *ppm
Hallway outside Sullivan Office	Pipe-chase Hallway	283	0
Office/ Conference Room	Center of room	8.8	0
215	Center of room Center renovation containment wall	15 33	1
214	Center of room Center renovation containment wall	15 21	0
112-Art Room	Center of room Center renovation containment wall	15 27	0
107	Center of room Center renovation containment wall	14 23	0
110	Center of room Drain clean-out in floor	25 44	0

* ppm = parts per million

[a] Device measures total airborne particulates of a diameter 0.02-1 micrometers